

Lower Cost, Improved Quality CL-20 Energetic Material

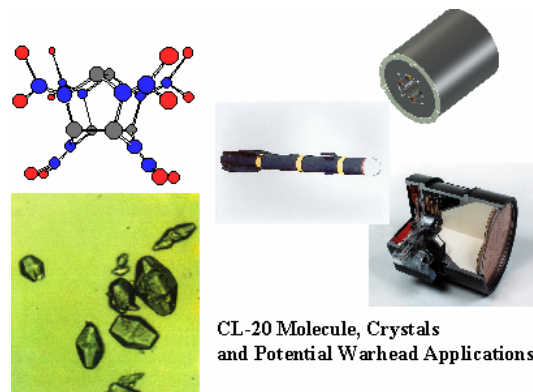
PROBLEM / OBJECTIVE

First synthesized in 1987 at the Naval Air Warfare Center in China Lake under ONR basic research support, CL-20 (hexanitrohexaazaisowurtzitane) is the most energetic conventional explosive available for military use and is therefore being considered for a range of military weapons. Candidate applications span both propellant and explosive uses and include weapon systems such Standard Missile, Advanced Gun System, Advanced Land Attack Missile, and Precision Guided Mortar Munition. To bring this new energetic material to the warfighter, the Navy MANTECH program has completed efforts to implement advanced process technology for the manufacture of CL-20 and CL-20-based energetic compositions that will improve sensitivity, product consistency, and quality while reducing costs. This project established a CL-20 manufacturing process that is affordable and reproducible at the industrial scale. Without a reproducible product at a reasonable price no weapon system will use this material, and the significant performance enhancements will not be achieved. CL-20 offers the only option within the next 10-15 years to meet weapon system size reduction goals without loss of performance. The Advanced Gun System (AGS) will require approximately 50,000 pounds per year to meet their stated weapon system objective, if a submunition payload is developed and fielded. Other Department weapon systems are expected to increase that demand for CL-20 over that same time period. CL-20 represents a general replacement for HMX in high explosives and propellants. US military need for HMX is approximately one million pounds per year, and it is expected that CL-20 will eventually replace HMX in approximately 20-30% of the applications.

ACCOMPLISHMENTS / PAYOFF

Process Improvement:

The Army and Navy CL-20 MANTECH programs were an integrated approach to making CL-20 lower cost, predictable and consistent for production. This effort includes the nitration, crystallization, and coating of CL-20. Under Army sponsorship, a process for the nitration of CL-20 has been implemented to produce CL-20 with greater than 99% purity at yields in excess of 90%. The Navy MANTECH project is focused on the crystallization of CL-20. Two crystallization processes, evaporative and inverse precipitation, have been demonstrated at the laboratory, and 50 gallon scales and have now been successfully transitioned to the full 500-gallon production scale. Three major process parameters that influence CL-20 crystal quality and morphology are the agitation rate, the solvent removal rate, and the percent of full reactor loading capacity. The effects of these parameters, as well as others, were determined via a matrix of designed experiments.



Full scale (500-gallon) demonstrations of both crystallization processes (inverse precipitation and evaporative) were completed in FY 02 at ATK-Thiokol.

Implementation and Technology Transfer:

A reproducible CL-20 manufacturing facility capable of producing 50,000 pounds per year has been established at the contractor in FY02. The contractor provided all equipment cost and shared in the cost of investigation. Once qualified, the CL-20-based explosive will be available to several warhead, high-energy rocket propellant, and gun propellant development programs for integration into weapon systems.

Expected Benefits:

The use of CL-20 could increase lethality of the specified weapon systems upwards of 25%. This increase would translate into either increased mission capability, given the same number of weapon systems, or significant cost avoidance due to fewer weapons being required to complete the same number of missions. Current estimates for submunition payload variants of the AGS and the Extended Range Guided Missile (ERGM) rounds run from \$10,000 to \$40,000 each. This successful MANTECH Program could result in not only the general cost avoidance identified above, but an overall reduction in the cost of the CL-20 from the current average of \$420 per pound to an average of \$315 per pound for AGS requirements of approximately 138,600 pounds over 5 years. Cost avoidance from FY06 through FY10 would amount to an average of \$2,133,000 per year.

TIME LINE / MILESTONES

Start Date: August 1998

End Date: September 2002

FUNDING

Navy ManTech: \$3.36M

PARTICIPANTS

Naval Surface Warfare Center - Indian Head Division
Energetics Manufacturing Technology Center (EMTC) and
ATK-Thiokol Propulsion